


Physiological age

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 An abbreviated version of this protocol was published in eLIFE in Feb 2020

Longitudinal trajectories, correlations and mortality associations of nine biological ages across 20-years follow-up

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Detailed protocol

Protocol for physiological age calculation:

1. Prepare two sets of data to hold the information of chronological age (CA), sex, and candidate biomarkers for study participants:
 - 1.1 The first one contains one measurement (the first available measurement) per individual (referred to as "baseline data")
 - 1.2 The second one contains multiple measurements (repeated measurements) per individual (referred to as "repeated data")
2. Examine the correlation between CA and each candidate biomarker and select age-associated biomarkers according to the absolute value of Pearson correlation coefficient (>0.1)
 - 2.1 Conduct analyses separately in men and women
 - 2.2 Use baseline data only
3. Perform principal components analysis (PCA) and derive principal components (PCs) using age-associated biomarkers which are selected from Step 2
 - 3.1 Note that the purpose of PCA is not to reduce dimensionality, but to take advantage of the fact that all the PCs are mutually uncorrelated variables. Kleméra-Doubal method used in the next step has an implicit assumption that all predictors of biological age (BA) are independent. However, the biomarkers considered are often correlated to varying degrees. Therefore, PCs would be treated as BA predictors in the next step instead of original biomarker values.
 - 3.2 Center and scale the original value of age-associated biomarkers to a mean of 0 and variance unit
 - 3.3 Conduct PCA analyses separately in men and women
 - 3.4 First, use baseline data, perform PCA, and derive PCs
 - 3.5 Next, derive PCs for repeated data. Two options (our analysis took the second way):
 - Repeat Step 3.2-3.4 for each measurement wave
 - Extract PCA loadings (i.e., weights for biomarkers) derived from the baseline data in Step 3.4 and use the baseline loadings to calculate PCs for repeated measurement such that PCs across all waves are constructed using the same biomarker loadings
4. Use function 34 of the Kleméra-Doubal method (KDM) (1) and calculate a combined biological age score (i.e., physiological age) using CA and PCs derived from Step 3
 - 4.1 Conduct PCA analyses separately in men and women
 - 4.2 Calculation could be implemented using TrueTrait function from R package WGCNA (Source code <https://rdrr.io/cran/WGCNA/src/R/TrueTrait.R>)
 - 4.3 First, use baseline data, perform KDM, and derive physiological age
 - 4.4 Next, calculate physiological age for repeated data. Two options (our analysis used the second option):
 - Repeat Step 4.3 for each measurement wave
 - Extract KDM weights derived from the baseline BA algorithm in Step 4.3 and apply the KDM weights to the repeated data so that all repeated measurements used the same algorithm to calculate physiological age
5. Notes
 - Step 1.2, 3.5, and 4.4 concerns repeated measurement and can be skipped in a cross-sectional measurement setting.
 - A simple illustration of Step 3.4 and 4.3 is shown in the attached R script output file.

Reference:

1. Kleméra P, Doubal S. A new approach to the concept and computation of biological age. Mech Ageing Dev. 2006;127(3):240-8.

Related files

 02_an_biological_age_KDM.pdf



How to cite: (Readers should cite both the Bio-protocol preprint and the original research article where this protocol was used)

1. Li, X. and Hägg, S. (2020). Physiological age. Bio-protocol Preprint. bio-protocol.org/prep634.
2. Li, X., Ploner, A., Wang, Y., Magnusson, P. K., Reynolds, C., Finkel, D., Pedersen, N. L., Jylhävä, J. and Hägg, S. (2020). Longitudinal trajectories, correlations and mortality associations of nine biological ages across 20-years follow-up. eLIFE. DOI: [10.7554/eLife.51507](https://doi.org/10.7554/eLife.51507)

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